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Fatal poisoning in Estonia 2000–2009. Trends in illegal drug-related deaths

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ABSTRACT

The aim of this study is to provide an overview of deaths caused by poisoning (especially illicit drugs) in Estonia from 2000 to 2009. The data on poisoning deaths ($N = 4132$) were collected from the autopsy reports of the Estonian Forensic Science Institute. Ethanol poisoning was the most frequent cause of death ($N = 1449$, 35.1%), followed by carbon monoxide ($N = 1151$, 27.9%) and poisoning from illicit drugs ($N = 888$, 21.5%). The study included 3267 male (79.1%) and 865 female fatalities, with the prevalent age group being 35–64 years. Since 2002, deaths from fentanyles have increased sharply and remained at a high level – from 63 cases in 2002 to 138 cases in 2009. This high number indicates that in spite of the state's drug policies, illegal drugs remain easily available and that this area requires more attention. Alcohol abuse prevention policies – restrictions on alcohol advertisements in the media, limitations on sale times and anti-alcohol campaigns concerning traffic – have not brought about a significant decrease in ethanol poisoning.

1. Introduction

Drug abuse remains a significant problem in society in many countries,[1,3,5,7,12–14] and the number of deaths from drug poisoning is an important parameter in the evaluation of drug problems in a country.

The total use of illicit drugs in a population is difficult to determine. Globally, the United Nations Office on Drugs and Crime (UNODC)[2] estimates that 155–250 million people (3.5–5.7% of the world's population aged 15–64) used illicit substances at least once in 2008. Globally, cannabis users comprise the largest number of such users. Amphetamine-group substances rank as the second-most commonly used drugs, followed by cocaine and opiates. Concerning fatal poisonings, cannabis is of no importance. Various approaches to estimating the drug abuse situation are available; each has its advantages and drawbacks. Drug-related deaths are recorded by specific agencies – for example, the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) reports the number of deceased addicts in the European Union (EU) and Norway,[3] while the Drug Abuse Warning Network (DAWN) publishes updated information on the number of deceased addicts in the United States.[4] Estonia submits data regarding drug use and drug-related deaths to the EMCDDA via its national focal point, the Estonian Drug Monitoring Centre. According to the EMCDDA's annual report for 2011, the estimated mortality rate among adults (15–64) due to drug-related deaths was 21 per million in Europe. Comparing neighbouring countries, this was highest in Estonia (146 deaths per million), followed by Norway (81), Finland (48) and Sweden (37).[3]

According to the EMCDDA, 6400–8500 overdose deaths are recorded in Europe each year,[3] but the pattern of use of illicit drugs and drug poisoning varies between countries. In the United States, during the 1980s and 1990s, the majority of drug-induced deaths were attributable to drugs such as heroin and cocaine. In the 2000s, a change occurred as prescription drugs, especially prescribed opioid painkillers and psychotherapeutic drugs, supplanted illicit drugs as the leading cause of drug-related overdose deaths.[5] In Australia, in 2001, deaths from opium, heroin and other opioids were ranked first, followed by benzodiazepines.[6] From 1997 to 2002, illicit drug-related deaths from opioids, amphetamines and cocaine were prevalent.[7]

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As the number of drug poisoning cases has increased in recent years in Estonia, the aims of this study are to give an overview of deaths caused by illicit drugs and to describe the current patterns of substances detected in biological samples from 2000 to 2009.

2. Methods

In accordance with the Establishment of Cause of Death Act, all assumed poisoning cases in Estonia are subject to forensic autopsy. This study is based on data collected from the autopsy reports of four regional departments of the Estonian Forensic Science Institute and from the Department of Forensic Chemistry during the period 2000–2009. All cases where the underlying cause of death was poisoning were included and International Classification of Diseases (ICD) codes T according to substance were used. The criterion in fatal poisoning was the lethal concentration of a toxic substance (legal or illegal) in the blood, fentanyles excluded. If fentanyles were found in the blood, urine and liver, this was considered fentanyle poisoning because of their extreme toxicity.[9] The criterion for heroin poisoning was the detecting of 6-monoacetylmorphine by gas chromatography. We analysed the characteristics of all poisoning deaths, including the age and gender of the deceased and the drug(s) involved. The main aim was to study deaths caused by illicit drugs.

In Estonia, in the case of unnatural deaths (certified or suspected), the police request a forensic autopsy. During the autopsy, samples of fluids (blood, urine and humour vitreous) are routinely collected. Blood alcohol concentration is measured in all cases; bodies in a state of decomposition and skeletisation and patients who had been hospitalised for a long period were excluded. Drugs were analysed in all traffic accidents, when a special request was made by the police or in cases where drug poisoning was suspected by the forensic doctors. Alcohol was determined using headspace gas chromatography (a Perkin Elmer AutoSystem XL in Tallinn and a Clarus 500 in Tartu, both with a TurboMatrix 40 Headspace Sampler). The presence of legal and illicit drugs in the body was identified in a variety of laboratory procedures: drug screening by immunoassay; urine screening tests were performed for amphetamine, metamphetamine, opioids (heroin/morphine), methadone, cocaine, marijuana, tricyclic antidepressants, benzodiasepines, barbiturates and fencyclidine; then all positive tests were confirmed as well as for detecting other synthetic drugs (not detectable with screening tests) using gas chromatography and mass spectrometry (using a Perkin Elmer Clarus 500 GC-MS or an Agilent Technologies 7890A GC and 5975C MSD or a Saturn 2000 Varian). Sample preparation includes hydrolysis, solid-phase extraction and derivatisation. Cases in which hydrolysis and derivatisation should be used depend on the drug being measured.

Poisoning involving one substance was considered mono-drug poisoning; those involving two or more substances poly-drug poisoning, one of them being the main and the other(s) additional substances.

3. Statistical analysis

Statistics were amassed using the STATA 9 statistical package and included a Chi-square test for dichotomous variables. A p-value of <0.05 was considered statistically significant.

4. Results

During the study period, 28,970 autopsies were performed at the Estonian Forensic Science Institute, 4132 of which involved poisoning, that is, 14.3% of all autopsies and 2.4% of the total number of deaths in Estonia (175,908 deaths were recorded from 2000 to 2009). Of these 4132 cases, blood and urine were analysed by the Department of Forensic Chemistry in 4042 cases; in the other 90 cases, poisoning was diagnosed at the hospital. The biggest group of poisoning diagnosed at the hospitals was with other alcohols (e.g., methanol, isopropanol and ethylene glycol) at 64.4% ($N = 58$), followed by illicit drug poisoning at 11.1% ($N = 10$) and medicine (legal drug) poisoning at 8.9% ($N = 8$).

Over the 10-year period, ethanol was the most frequent cause of death ($N = 1449$), followed by carbon monoxide (CO) ($N = 1151$) and poisoning with illicit drugs ($N = 888$). During this period, 284 poisoning cases from other alcohols were recorded. A statistically significant trend during the period was a decrease in alcohol poisoning ($p < 0.05$). Mono-intoxication deaths (involving a single substance) were mostly alcohol related. In total, 2248 cases (54.4%) involved one substance (mono-drug poisoning). In comparison with mono-intoxications, poly-drug poisoning is frequent in CO and illegal drug-related poisoning. Combined poisoning was diagnosed in cases of poisoning with substances of a similar toxicity, as well as in cases where two or more substances were determined to be at potentially lethal concentrations or where none of the drugs was at a lethal concentration but their coalitive effect was toxic (e.g., ethanol with benzodiazepines). Other rare cases were poisoning with acids, alkalis and volatile substances (Table 1).

The study included 3267 male (79.1%) and 865 female (20.9%) fatalities.

Fatal intoxication cases were prevalent in the 35–64 age group; only 42 victims were younger than 16, most of whom suffered CO

Table 1
Poisoning deaths in Estonia, 2000–2009.

Substance	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total
Ethanol	200	221	140	173	176	120	108	138	97	76	1449
Total illegal drugs	32	43	100	49	121	70	89	119	108	157	888
Opiates	18	24	83	29	90	55	76	107	100	150	732
Stimulants	5	2	12	8	16	7	8	9	6	5	78
Total medicines	7	15	21	12	18	19	16	15	16	16	155
Tricyclic antidepressants	2	2	6	7	8	8	4	3	8	8	56
Neuroleptics	3	1	6	3	1	3	4	3	0	1	25
Other alcohols	25	78	25	16	15	31	46	24	8	16	284
Methanol	2	50	12	5	8	12	36	10	4	11	150
Surrogates[a]	15	20	6	10	5	17	7	5	2	1	88
Carbon monoxide	106	132	109	150	122	135	141	115	84	57	1151
Combined	22	24	21	4	0	7	16	14	10	12	130
Other	1	7	7	3	5	4	5	3	5	6	46
Unknown	3	0	9	2	2	3	0	6	1	3	29
Total	396	520	432	409	459	389	421	434	329	343	4132

[a] Surrogates – poisonings diagnosed at the hospitals.

poisoning (male/female ratio: 19:23), while one was older than 90 (poisoning with barbiturate and benzodiazepine). The gender and age distribution is shown in Fig. 1.

In cases of fatal poisoning, it is often difficult to determine an intention of death; this depends greatly on preliminary and additional data received from the police and on the victim's previous health. As it is not always possible to determine whether drugs are used accidentally or to commit suicide, 3.7% of the cases in question remained undetermined and were considered neither accidents nor suicides, 3.5% of fatal intoxications were classified as suicides and 92.7% as accidents. Only four cases were classified as assault: two were poisoning with CO, one with benzodiazepines and one with selenium.

4.1. Illicit drug poisoning

Retrospective analysis showed that 888 drug-related deaths occurred in Estonia during the study period, poisoning with 3-methylfentanyl (45.7%) and fentanyl (19.6%) ranking highest ($N = 63$ in 2002, $N = 138$ in 2009, total number 580), followed by morphine/heroin (10.8%), amphetamine (7.2%) and methadone (6.3%). From 2000 to 2002, the main opiate used was poppy straw, although due to its relatively low toxicity, the number of fatal poisoning cases remained low and stable. The number of deaths caused by fentanyl was remarkable in 2002 and 2009 (Fig. 2). An epidemic of poisoning due to 3-methylfentanyl was seen in Estonia between 2004 and 2008. Over the 10 years the mortality rate from illicit drug poisoning was 888 of all 175,908 deaths in Estonia.

4.2. Gender and age distribution in illicit drug poisoning

Of all reported drug poisoning, 789 involved male fatalities and 99 involved female fatalities; 764 were in the 16–34 age group. The average age of those who died due to illegal drug poisoning was 28.1 (95% CI 27.5–28.7): 27.8 for men (95% CI 27.3–28.3) and 30.3 for women (95% CI 27.3–33.3). The youngest male who died due to illegal drugs was 15 and the youngest female 10; the oldest were, respectively, 56 and 64, if we exclude deaths due to legal barbiturates and benzodiazepines. Gender and age distribution was similar for all years.

4.3. Mono- and poly-drug use

Fatal poisoning from more than one illegal drug (i.e., poisoning due to one drug and alcohol or to two or more drugs with or without alcohol) is referred to herein as poly-drug poisoning (Table 2). Fatal illicit drug poisoning tended to be poly-drug poisoning (73%).

Blood ethanol concentration was below 0.2 mg g^{-1} in 542 cases (61.0%), which shows that the victims did not consume alcohol prior to death. The biggest group of drug abusers had a blood alcohol content (BAC) of 0.50–1.50 mg g^{-1}. In seven cases, the BAC was over 3.0 mg g^{-1}, and in one case of poisoning with 3-methylfentanyl it was 4.38 mg g^{-1}. The median BAC values were mostly 0 (Table 3). 3-Methylfentanyle and fentanyle were often combined, possibly from production of 3-methylfentanyle from fentanyle in illegal laboratories. Most commonly, illegal drugs were combined with benzodiazepines and amphetamine, followed by methadone and opiate alkaloids. In some poisoning cases with illicit drugs, medicines were found in the blood – most frequently non-steroid inflammatory drugs ($N = 53$), narcotic analgesics ($N = 27$) and tricyclic antidepressants ($N = 26$) (Table 4).

5. Discussion

During the study period from 2000 to 2009, the total number of poisoning deaths remained stable, varying from 329 to 459 and peaking in 2001 at 520 as a result of a catastrophically high number of methanol poisoning in the autumn of that year ($N = 68$).[8] During the same period, the number of deaths caused by ethanol poisoning decreased and illegal drug poisoning increased. One reason for the decrease in ethanol poisoning can be attributed to changes in the Establishment of Cause of Death Act: this law made it possible for family doctors to issue death certificates without an autopsy in the case of suspected disease, with no toxicological analysis carried out. In summer 2001, fentanyl reached the Estonian illicit drug market, causing a sharp increase in drug poisoning in 2002. The same pattern could be seen in 2003, when 3-methylfentanyl replaced fentanyl.[9] Since then, mortality from fentanyles has remained at a high level. The number of poisoning cases from CO was high throughout the years under study (more than 100 cases per year). Since homes have had to be fitted with automatic fire alarm

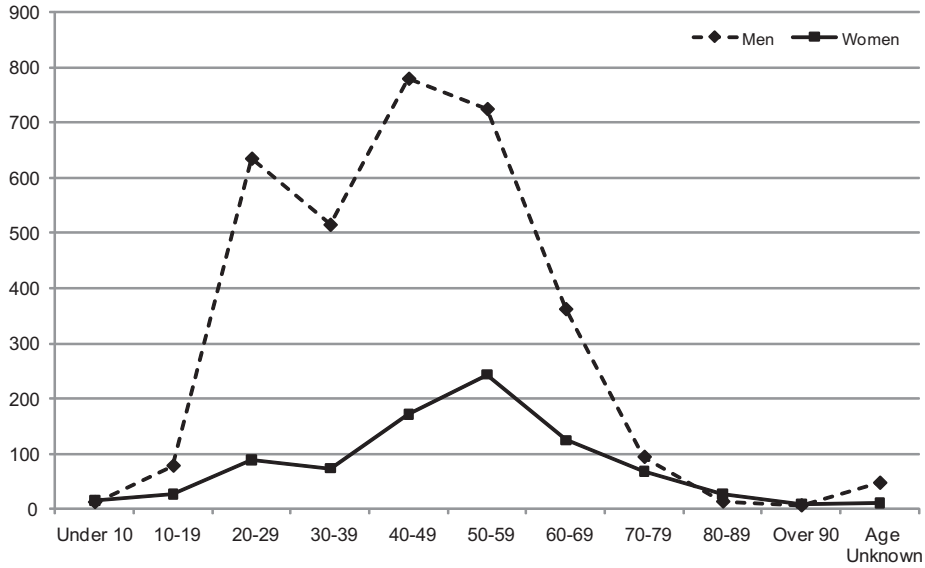

Fig. 1. Age and gender distribution of poisoning deaths in Estonia, 2000–2009.

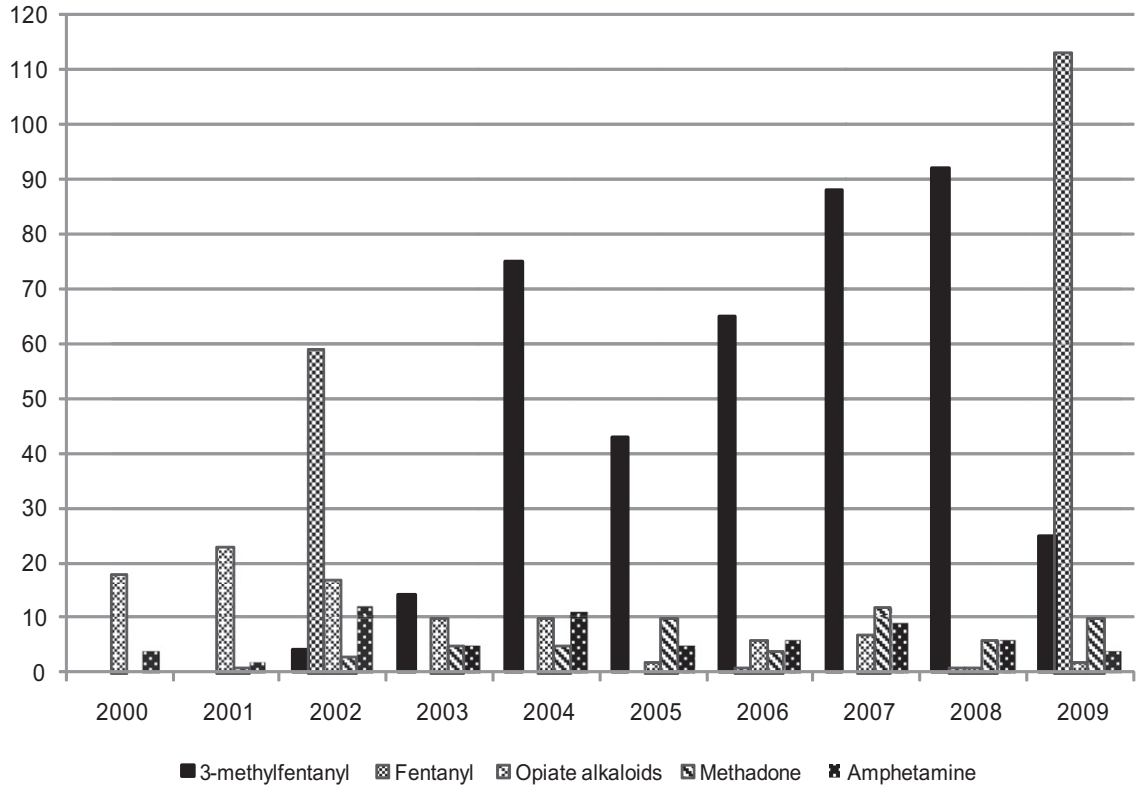

Fig. 2. Illegal drugs causing most poisoning deaths in Estonia 2000–2009.

systems (smoke alarms), deaths due to CO poisoning have decreased to 57 in 2009.

The mortality rate from illegal drug poisoning is high in Estonia – 888 cases were registered from 2000 to 2009 (from a population of 1.4 million, in average 6.3 per 100,000 inhabitants over the ten years). In comparison with neighbouring Latvia, the mortality rate from illegal drugs is quite low – from 1999 to 2009, there were 265 drug-related deaths (11.9 per 100,000 inhabitants).[10] In Finland (which has approximately five times more inhabitants than Estonia), illegal drug-related deaths increased from 87 to 169 between 1998 and 2008 (1.7–3.4 per 100,000 inhabitants).[11,12]

The average age of victims of illegal drug poisoning was 28.1, which was similar to other studies.[10] In the Nordic countries (Sweden, Finland, Denmark, Iceland and Norway), fatal intoxication was most common in Denmark among the 35–39 age group, but in the other countries the highest frequency was in the 25–29 age group.[12] In two studies, from Australia and Italy,[13] an increase in median age was observed: from 25 to 31 between 1979 and 1995 and from 26 to 34 between 1985 and 1998. Age distribution has remained similar throughout the years covered by our study.

Table 2
Distribution of illegal drug poisonings based on number of drugs and other substances (ethanol and other alcohols) detected.

Poisoning substance	No.	%
Mono-drug	239	26.9
Two or more drugs	290	32.7
One drug + other substance	195	22.0
Two drugs + other substance	78	8.8
Three drugs + other substance	31	3.5
Four drugs + other substance	9	1.0
Five drugs + other substance	2	0.2
Six drugs + other substance	1	0.1
Unknown number of drugs + other substance	43	4.8
Total	888	100.0

The other substance in most cases was ethanol; in one case it was methanol.

In our study of all ($N = 888$) illegal drug poisoning, 789 were male fatalities; the male/female ratio was 8:1, similar to the Nordic countries.[14]

In Norway and Sweden, heroin/morphine has been the most common cause of death in the last 15 years.[12,15] In Latvia, deaths from illegal drugs have resulted mostly from heroin/morphine and amphetamine.[10] From 2000 to 2002, heroin and morphine poisoning were prevalent and showed a statistically high level in Estonia; since 2003 only 5–10 cases have been registered per year. This can be explained by stricter controls on the Estonian–Russian border. Heroin transit via Russia was a common route for transporting the drug from Afghanistan to Estonia and elsewhere in Europe. Of all illegal drug poisoning in Estonia, 580 (65.3%) were caused by fentanyles. Since 2009, poisoning with fentanyl and 3-methylfentanyl has been ranked highest, which is unique among EU Member States.[9] In comparison with Estonia, there have only been rare cases of poisoning with fentanyles in nearby countries, which indicates that they may be produced locally. Fentanyl is approximately 50–100 and 3-methylfentanyl 6000–7000 times as potent as morphine,[9,16] which may explain why they cause overdoses so frequently. Finding 3-methylfentanyl and fentanyl in blood samples indicates the impure/incorrect synthesis of 3-methylfentanyl from fentanyl in illegal laboratories. Poisoning involving fentanyles is frequently ($N = 71$) combined with amphetamines (and mostly with amphetamine itself). The use of fentanyles combined with amphetamine could be the Estonian version of 'speedball'. Generally, 'speedball' consists of cocaine and heroin for an extra-strong influence (or 'high').[16]

Methadone and buprenorphine are both used for substitution therapy or as illegal drug by drug addicts; in Estonia, methadone

Table 3
Illegal drug poisonings combined with alcohol concentration in blood (BAC) 2000-2009.

Blood alcohol concentration (BAC) mg/g											
Illicit drug	0.00–0.19	0.20–0.49	0.50–1.50	1.51–2.5	≥2.5	Unknown concentration	Total	Mean concentration	95%CI	Min	Max
3-Methylfentanyl	247	15	85	51	7	1	406	0.51	(0.43–0.58)	0	4.38
Fentanyl	107	2	33	20	4	8	174	0.48	(0.36–0.60)	0	3.52
Methadone	39	1	9	5	1	1	56	0.38	(0.19–0.57)	0	3.25
Opiate alkaloids	48	1	16	22	4	5	96	0.76	(0.57–0.95)	0	3.05
Barbiturates	15	0	2	5	0	1	23	0.55	(0.17–0.93)	0	2.49
Benzodiasepines	14	0	6	1	1	2	24	0.56	(0.17–0.94)	0	3.23
Amphetamines	47	2	9	4	1	1	64	0.29	(0.13–0.45)	0	2.64
Ecstasy	5	0	1	0	0	0	6	0.19	(0.00–0.67)	0	1.13
Cocaine	3	0	2	3	0	0	8	0.97	(0.25–1.69)	0	2.01
GHB	0	0	1	0	0	0	1	0.98	–	0.98	0.98
Tetrahydrocannabinol	2	0	0	0	0	0	2	0	–	0	0.00
Unknown substance	15	0	5	6	0	2	28	0.71	(0.33–1.09)	0	2.40
Total	542	21	169	117	18	21	888	0.52	(0.46–0.57)	0	4.38

Table 4
Death causing illegal drugs combined with other illegal drugs detected.

Main drug	Co-found drugs									
	Fentanyles	Opiate alkaloids	Methadone	Barbiturates	Benzo-diasepines	MDMA	Amphetamines	Cocaine	Cannabis metabolites	GHB
3-Methylfentanyl	10	16	21	10	63	13	65	3	15	0
Fentanyl	0	10	9	2	34	2	6	0	5	0
Methadone	0	6	0	5	20	0	1	0	1	0
Opiate alkaloids	1	0	3	3	20	1	4	0	1	0
Barbiturates	0	1	0	0	10	0	0	0	1	0
Benzodiasepines	0	0	0	0	0	0	0	0	0	0
Amphetamines	3	12	7	5	12	4	2	0	2	0
MDMA	0	0	0	0	0	0	0	0	1	0
Cocaine	1	1	0	0	2	0	0	0	0	1
GHB	0	0	0	0	0	1	0	0	0	0

tends to be used because of its lower price, and therefore no deaths caused by buprenorphine have been determined. A survey of Estonian drug addicts in 2010 also highlighted the popularity of methadone because of its low price.[17] According to the National Drug Treatment Database, 618 methadone treatment cases were recorded in Estonia in 2008 and 687 in 2009 per approximately 13 000 injecting drug abusers.[18] In our study, 6.3% of poisoning was caused by methadone. Deaths from methadone overdoses have increased in the Nordic countries: it was the main intoxicant in Denmark in 2007, accounting for 51% of poisoning cases. Finland differs from the other Nordic countries in having a high number of poisoning cases caused by buprenorphine and very few caused by heroin/morphine. The total number of buprenorphine deaths in Finland doubled from 16 in 2002 to 32 in 2007, when it constituted 25% of all such deaths.[11,12]

During the study years, two cases where the cause of death was poisoning by cannabis were registered. Due to the low toxicity of cannabis, it is possible that these were poly-drug poisoning cases, and according to the EMCDDA's findings, a narcotic drug must have been the main cause.[19]

Barbiturates and benzodiazepines are prescription medicines in Estonia, but they are often also used illegally. Without additional data from the police, forensic pathologists are unable to determine their origins, which is why we included them in our study as illegal drugs.

In Estonia, fatal illicit drug poisoning has tended to be poly-drug poisoning mainly resulting from two or more drugs – mostly a psychotropic medicine or other illegal drug, or one drug plus ethanol. A general toxicological screening programme showed widespread multi-drug use in all of the Nordic countries. The average number of drugs per case varied from three to five.[12]

6. Conclusion

The number of illegal drug-related deaths is high in Estonia and has increased sharply since 2002, when heroin and poppy straw were replaced by extremely toxic fentanyles. The high number of deaths indicates that in spite of the state's drug policies, illegal drugs remain easily available and that this area requires more attention.

Conflict of interest

Authors have no conflict of interest.

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Ethical approval

None declared.

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